Aestivation in the Australian Freshwater Crocodile?

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INTRODUCTION

Stranding of Australian freshwater crocodiles, *Crocodylus johnstoni,* in drying waterholes or river beds has been reported frequently to fauna management authorities in the Northern Territory (CCNT unpublished data). Sometimes the Commission has responded to these reports by relocating small numbers of crocodiles to permanent water. However, the crocodiles' behavioural and physiological responses to complete drying of their aquatic habitats have not been examined in detail.

In 1986 six crocodiles were relocated from a drying pool in the bed of Saunders Creek, a tributary of the Margaret River, approximately 200 km south of Darwin. As it appeared likely that the creek bed would again dry following below average rainfall during the 1986-87 wet season, the pool and adjacent areas of the creek were monitored for the presence of freshwater crocodiles from September 1987.

Here I report observations of a number of crocodiles that remained in shallow caves in the banks of the dry creek bed for a period of several months.

The site

The Top End of the Northern Territory has a highly seasonal climate. Most rain falls during a hot wet season (December to April) and little or no rain falls during a prolonged cooler dry season. Total annual rainfalls in 1986 (1 200 mm) and 1987 (1 225 mm) were slightly below the long term mean (1 263 mm) for the weather station nearest the site (Emerald Springs Station).

Saunders Creek is described by local people as an intermittently flowing stream. The stream is narrow (less than 10 m wide) through most of its length and fringed by *Melaleuca* and *Terminalia* species. Banks are steep (close to perpendicular) and up to 3 m high. Banks are undercut in a number of locations to form shallow caves that appear to be stabilized by dense fibrous mats of tree roots.

The pool that is the focus of my observations is among the last in the creek to dry. Three caves were found at the level of the creek bed within 30 m of this pool. Two caves were approximately 2 m long, 1 m deep and 35 cm high from floor to roof. A larger cave stretched for about 7 m along the creek bank and was undercut to depths of 1.5-2.0 m. The cave was up to 40 cm high, being highest at the rear and narrowing to 25 cm at its entrance. The cavern sloped upwards from the creek bed at about 35°.

Observations

2 September 1987: The pool contained a few litres of water and no crocodiles. Three caves adjacent to the pool were searched and 14 crocodiles counted. One large male from each of two smaller caves was relocated to permanent water in a different catchment, leaving these smaller caves empty. Animals remaining in the large cave were not disturbed.

9 September 1987: The pool was completely dry. All 12 crocodiles visible in the large cave were marked with daubs of yellow paint.

9 September to 8 November 1987: There was no evidence of crocodiles leaving the cave until 8 November when tracks of one small animal were found leading from cave to pool and back again. The pool then contained a few litres of water from an early rainstorm.

8 November 1987: All crocodiles were captured, weighed, measured (snout-vent length and total length), individually marked by cutting a sequence of tail scutes, and sexed by cloacal examination. Wet and dry bulb temperatures of the cavern were recorded. Body temperature (deep cloacal) was measured and samples of blood and cloacal material also taken. Body weights and snout-vent lengths are given in Table 1. Other data will be reported separately (K. Christian and R. Kennett, in prep.).

13 December 1987: The creek was completely dry and all crocodiles were alive and present in the cave.

16 December 1987: The creek was found to be in flood following heavy rain in the Saunders Creek area on the night of 15 December. Six marked crocodiles were seen among debris in the turbid water of the rapidly flowing creek.

21 December 1987: The creek continued in flood. No trace of crocodiles was found despite spotlight searches at night and netting of the creek by day.

Table 1. Size and sexes of animals found in shallow caves at the Saunders Creek site.

Sex	Number	Snout-vent length (cm)	Body weight (kg)
Male	1901	107.3	30.65
	1903	81.0	10.15
	1904	76.0	7.45
	1905	73.6	7.15
	1906	79.0	10.65
	1909	73.0	6.65
	1910	62.4	5.15
	1911	74.0	6.65
	1913	50.6	2.15
	1914	51.0	2.15
(data not recorded for 2 large males relocated)			
Female	1902	58.3	3.65
	1907	90.0	14.15
	1908	82.1	11.65
	1912	61.8	5.10
	1916	45.0	1.40
	1917	67.0	5.0
Juvenile (sex unknown)	1915	—	0.95

DISCUSSION

The Australian freshwater crocodile may respond to loss of dry season habitat by moving to a new pool (Webb and Gans 1982). However, this option may not be available in water courses that retain only a few widely spaced pools, or dry completely. My observations clearly show that *C. johnstoni* may seek refuge in subterranean shelters when adjacent waters dry entirely. The nearest permanent water in 1987 when the crocodiles were first recorded in the caves was 15 km downstream.

Erratic variation in the time of onset of wet season rainfalls may cause pools that generally hold water year-round to dry completely in some years (Taylor and Tulloch 1985). Given this possibility and the large number of intermittently flowing streams known to be inhabited by *C. johnstoni*, I expect such refuge-seeking behaviour to be quite common. Other observations suggest that it may occur even when water continues to be available. Captive sub-adult *C. johnstoni* housed in earthen ponds burrow extensively, sometimes causing the collapse of banks. The caves used at the Saunders Creek site appeared to have been enlarged by the crocodiles inhabiting them. Crocodiles occupying riverine habitats in parts of north Queensland may retreat to quite large burrows, considerably complicating capture programmes (C. Limpus unpublished).

Other species of crocodiles also burrow to avoid adverse environmental conditions. The Nile crocodile, *Crocodylus niloticus,* seeks shelter in caverns during the dry season (Cott 1961; Pooley 1982) and the American alligator, *Alligator mississippiensis,* hibernates in flooded burrows (Neill 1971).

Advantages for *C. johnstoni* seeking shelter in caves are obvious when free water ceases to be available: they include predator avoidance, improved thermoregulation, and reduced rates of dehydration. However, these benefits may also apply when a small volume of free water remains. Risk of predation is likely to be lower in a cavern than in an exposed shallow pool. Ambient temperatures in caves are likely to be several degrees cooler than in residual pools in which water temperature often exceed 30°C (pers. obs.). Use of caves may reduce body temperatures of crocodiles, thereby reducing metabolic rate and energy consumption during a period when crocodiles are unable to feed. For example, on 8 November, temperature in the river bed was 30°C, 3.1°C higher than in the cave. In mid-afternoon, humidity in the cavern (92%) was very much higher than in the river bed (68%) which, in combination with the lower cave temperature, would substantially reduce rates of evaporative water loss. Physiological correlates of the sheltering behaviour are currently being investigated, but the phenomenon also raises interesting ecological questions.

The sex ratio (12 males: 6 females) of the sheltering group does not differ significantly from 1.0 ($\chi^2=2.0$, $P>0.10$). However, it is significantly higher than the adult sex ratio of 1:3-4 reported by Webb *et al.* (1983a) for populations in the nearby McKinlay River ($\chi^2=18.1$, $P<0.01$ assuming a 1.0 : 3.5 ratio): this conclusion would hold even if the juvenile of unknown sex was female.

Dry season crocodile densities may be very high in permanent pools such as those of the McKinlay River (Webb *et al.* 1983b). Reproductive activity and nesting is centred on these pools during the mid to late dry season (Webb *et al.* 1983a). Aggressive encounters and injuries are common (Webb and Manolis 1983). Are sheltering crocodiles part of the reproductive population, or have they been displaced from other more favourable habitats by reproductively active animals? Is the slight male bias in this sheltering population related to the female bias among crocodiles captured in permanent pools? It is perhaps significant that the Saunders Creek site with its steep banks and rocky surrounds appears to lack suitable nesting sites.

This apparently widespread phenomenon certainly justifies further research. However, these preliminary observations indicate that the concern prompting relocation of freshwater crocodiles from drying habitats may be misplaced. The practice should be discontinued except where the animals are clearly at risk.

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Letters to the Editor

Dear Sir,

In my citation of Michael Archer for Fellowship of the Society, my enthusiasm exceeded my accuracy and, without detracting from Professor Archer's many achievements, I would like to correct my statement that he formed the Ethel Mary Reed Research Grants Scheme.

This, in fact, was a project originated by Claudia Ford when she was treasurer of the Society. It is to her that we owe the proposal to sell the Society's flat and to devote the interest on the funds received to research grants. Ms Ford developed her proposal into a firm and feasible plan and, not without some opposition, persuaded Council to accept it. She was convener of the first Ethel Mary Reed Grants Committee.

This Committee is now such an established part of the Society's activities that we tend to forget that it had to have a beginning. I, for one, had forgotten its origin.

Yours faithfully,

Ronald Strahan,
National Photographic Index of Australian Wildlife

President
R.Z.S., P.O. Box 20
Mosman, NSW 2088
27 February, 1989

Dear Dan,

I presume the front cover of the recent issue of *Australian Zoologist* was intended as an illustration of the note by David Carter, as well as a nice picture. Unfortunately, the vital bit seems to have been cropped — these things happen to the best of editors!

Would it be possible to publish a small black and white version of the picture in the next issue so that we can see the finished product in use? The hide has potential but it would be nice to see the way it fits the user.

Kind regards and best wishes,

C. N. Smithers, Research Associate
Australian Museum